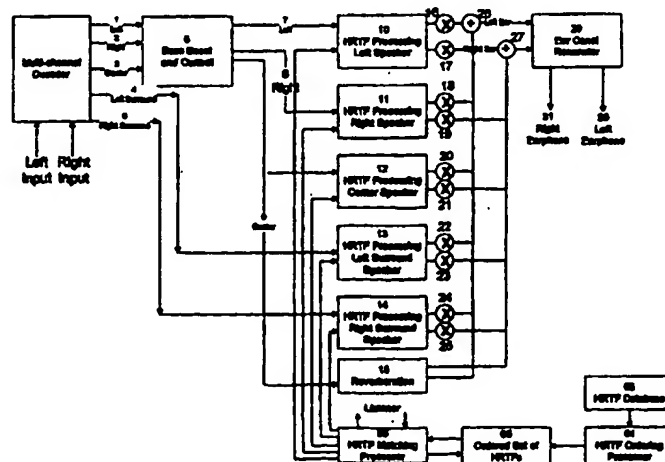




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04S 1/00, 5/00, 3/00		A3	(11) International Publication Number: WO 97/25834
			(43) International Publication Date: 17 July 1997 (17.07.97)
(21) International Application Number: PCT/US97/00145		(81) Designated States: AL, AU, BA, BB, BG, BR, CA, CN, CU, CZ, EE, GE, HU, IL, IS, JP, KP, KR, LC, LK, LR, LT, LV, MG, MK, MN, MX, NO, NZ, PL, RO, SG, SI, SK, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).	
(22) International Filing Date: 3 January 1997 (03.01.97)			
(30) Priority Data: 08/582,830 4 January 1996 (04.01.96) US 08/726,518 7 October 1996 (07.10.96) US 08/726,590 7 October 1996 (07.10.96) US			
(71) Applicant (for all designated States except US): VIRTUAL LISTENING SYSTEMS, INC. [US/US]; 4637 N.W. 6th Street, Gainesville, FL 32609 (US).		Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.	
(72) Inventors; and (75) Inventors/Applicants (for US only): TUCKER, Timothy, J. [US/US]; 2215 N.W. 9th Place, Gainesville, FL 32609 (US). GREEN, David, M. [US/US]; 399 Federal Point Road, East Palatka, FL 32131 (US).		(88) Date of publication of the international search report: 18 September 1997 (18.09.97)	
(74) Agents: PARKER, James, S. et al.; Saliwanchik, Lloyd & Saliwanchik, Suite A-1, 2421 N.W. 41st Street, Gainesville, FL 32606-6669 (US).			

(54) Title: METHOD AND DEVICE FOR PROCESSING A MULTI-CHANNEL SIGNAL FOR USE WITH A HEADPHONE



(57) Abstract

A method and device processes multi-channel audio signals, each channel corresponding to a loudspeaker placed in a particular location in a room, in such a way as to create, over headphones, the sensation of multiple "phantom" loudspeakers placed throughout the room. Head Related Transfer Functions (HRTFs) are chosen according to the elevation and azimuth of each intended loudspeaker relative to the listener, each channel being filtered with an HRTF such that when combined into left and right channels and played over headphones, the listener senses that the sound is actually produced by phantom loudspeakers placed throughout the "virtual" room. A database collection of sets of HRTF coefficients from numerous individuals and subsequent matching of the best HRTF set to the individual listener provides the listener with listening sensations similar to that which the listener, as an individual, would experience when listening to multiple loudspeakers placed throughout the room. An appropriate transfer function applied to the right and left channel output allows the sensation of open-ear listening to be experienced through closed-ear headphones.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France			UZ	Uzbekistan

INTERNATIONAL SEARCH REPORT

Intern. Application No.

PCT/US 97/00145

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 6 H04S1/00 H04S5/00 H04S3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04S H04R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 438 623 A (BEGAULT) 1 August 1995	1-7,15, 17,21, 32,38 22-26
A	see column 5, line 63 - column 7, line 27 ---	
X	EP 0 505 949 A (NIPPON TELEGRAPH & TELEPHONE) 30 September 1992	30
A	see page 17, line 24 - page 18, line 41 ---	1,15
A	WO 95 23493 A (MOELLER ET AL.) 31 August 1995	1,15,30
	see page 5, line 2 - page 8, line 24 ---	
A	WO 95 17799 A (CENTRAL RESEARCH LAB LTD ET AL.) 29 June 1995	1,15,30
	see page 2, line 17 - page 4, line 2 ---	
	-/--	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

4 July 1997

Date of mailing of the international search report

18.07.1997

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl,
 Fax (+ 31-70) 340-2016

Authorized officer

Gastaldi, G

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 97/00145

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 739 513 A (KUNUGI ET AL.) 19 April 1988 see column 5, line 10 - column 8, line 26; figures ---	1,15
A	WO 95 31881 A (CRYSTAL RIVER ENGINEERING INC) 23 November 1995 see page 8, line 20 - page 15, line 2 ---	1,15,30
A	US 5 404 406 A (FUCHIGAMI ET AL.) 4 April 1995 see column 4, line 20 - column 6, line 7 ---	1,15,30
A	US 5 371 799 A (LOWE ET AL.) 6 December 1994 see column 2, line 2 - line 48 -----	1,15,30

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern. Application No

PCT/US 97/00145

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5438623 A	01-08-95	NONE	
EP 0505949 A	30-09-92	JP 4295728 A JP 7039968 B DE 69207039 D DE 69207039 T US 5187692 A	20-10-92 01-05-95 08-02-96 12-09-96 16-02-93
WO 9523493 A	31-08-95	AU 1755595 A CA 2184160 A EP 0746960 A	11-09-95 31-08-95 11-12-96
WO 9517799 A	29-06-95	EP 0737410 A	16-10-96
US 4739513 A	19-04-88	JP 60254997 A JP 1797135 C JP 5003928 B JP 61108214 A JP 7054998 B JP 61108294 A EP 0165733 A	16-12-85 28-10-93 18-01-93 26-05-86 07-06-95 26-05-86 27-12-85
WO 9531881 A	23-11-95	AU 2460395 A EP 0760197 A	05-12-95 05-03-97
US 5404406 A	04-04-95	JP 6178397 A JP 6178398 A	24-06-94 24-06-94
US 5371799 A	06-12-94	NONE	